MEMORANDUM ON MEASURES TAKEN FOLLOWING THE SINKING OF CAR FERRY MS ESTONIA AND PLAN FOR JOINT ACTION IN THE NORDIC COUNTRIES

Working group on bow doors

National Board of Navigation

Maritime Department
Helsinki 1994

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On 28 September 1994 an ad-hoc meeting led by minister of transportation Ole Norrback convened to discuss immediate measures to be taken following the sinking of car ferry Estonia.

It was pointed out at the meeting that all passenger vessels regularly calling at Finnish ports are subjected to safety inspections. These inspections also include foreign vessels. The inspections are based on both international conventions and national legislation.

As a response to the Estonia disaster, the parties decided on the following additional measures to be taken:

1. Inspection of bow doors in Finnish car and rail ferries

The National Board of Navigation was to inspect urgently the bow and stern doors of all car and rail ferries that fly the Finnish flag and call at Finnish ports. The inspection was to include both condition and functioning of the doors as well as their alarm and monitoring systems and was to be completed within a week.

The National Board of Navigation was also to verify that the passenger vessels, car and rail ferries maintain such routines that the closing of all cargo doors is secured before departure.

These inspections were completed by October 8th, as follows:

Vessel	Year of Build	Type of bow door	Date
Cinderella	-89	butterfly type	29.09.
Mariella	-85	visor	29.09.
Isabella	-89	butterfly type	30.09.
Silja Festival	-85	"	30.09.
Silja Europa	-93	"	30.09.
Wasa Queen	-75	visor	30.09.
Fennia	-66	"	30.09.
Mariella (renewed insp.)			01.10.
Silja Serenade	-90	butterfly type	03.10.
Rosella	-85	visor	04.10.
Amorella	-88	butterfly type	05.10.
Finnmaid	-72	side door, bow	05.10.
Finnfellow	-73	"	05.10.
Alandia	-72	visor	06.10.
Roslagen	-73	"	08.10.
Birka Princess	-86	side door, stern	08.10.

The closing devices in the bow door of the Finnjet had been welded before inspection.

Having analysed the findings of the inspections, the Board took the following preliminary decisions:

A regular door maintenance procedure has to be created, which provides for the proper functioning of the door, its construction, the manoeuvring consol, the hydraulics and electrically operated functions. Inspections shall be carried out with regular intervals and be properly recorded. Any door maintenance or repair work shall be recorded, too.

Periodical door inspections shall be included in the surveys carried out by the Administration. They shall be carried out in cooperation with the classification society concerned and/or the manufacturer of the equipment.

The bow doors of all passenger ships shall be put under scrutiny and their construction and closing devices shall be modified, according to the latest knowledge, so as to tolerate the stress they are exposed to.

2. Inspection of foreign car ferries/passenger vessels calling at Finnish ports

All foreign passenger vessels regularly calling at Finnish ports were to be subjected to an additional Port State Control inspection, which included supervised fire and life-saving drills for the crew, the extent of which was determined by the Administration.

All passenger vessels plying between Finland and Estonia were inspected by October 11th. A detailed report on these inspections was written and submitted to the Estonian authorities on October 21th.

To sum up, the following conclusions can be drawn from these inspections:

One ship was detained due to technical defects, whereas several requests for minor repairs were made. The defects were of various degree and caused by wear/corrosion and lack of maintenance. Some of them were found in Finnish vessels, too.

As for the operational controls, it is clear that the drills did not reveal such smooth routines as on the ferries plying between Finland and Sweden. Therefore, the companies concerned should recruit a safety supervisor, reporting to the top management, who could assist the crews in developing and coordinating their safety procedures.

The Finnish National Board of Navigation should assist the Estonian authorities in developing their inspection and survey procedures.

3. Law on the safe operation of ships

A government bill concerning the safe operation of ships is to be submitted to Parliament along with a proposal for new provisions concerning the safety management system of shipowners. The bill shall be submitted to Parliament by mid-November.

The bill was handed over to minister Norrback on October 11th and is circulating for comment since October 17th.

The essence of the bill is as follows:

An Act is to be enacted, which would combine current provisions concerning the inspection of ships' seaworthiness, now included in a decree, with new, supplementary provisions. The bill includes provisions concerning the safe operation of ships, the shipowner's safety management system, the responsibilities of the personne,l and pollution prevention.

The bill determines authorities competent to exercise control, their duties and competence. It widens their competence. The bill also includes provisions for sequel and coercive measures and appeal. The sequel and coercive measures would count conditional imposition of a fine, threat of suspension and restraint on the right to work in any seafarer's profession.

At the same time the Maritime Act would be amended and supplemented with provisions on ship safety and the safe operation of ships by the shipowner's shore-based organization and penalties for neglecting these provisions. Violation of the law could ultimately lead to a restraint on the shipowner's right to act as such.

By virtue of the Maritime Act a decree would be amended to provide for mandatory registration of all passengers on board.

A bill is also to be introduced in order to amend the law relating to the prevention of the pollution of the marine environment with respect to those provisions pertaining to the surveillance of the compliance with the law and regulations issued by virtue of it.

These acts would enter into force at a later date, prescribed by a decree. The objective is that the main part of the legislation would enter into force on 1 July 1995. The provisions concerning the safety management system, shipboard safety operations and the supervision thereof would enter into force gradually depending on the type of vessel. They would first be applied to passenger vessels and tankers.

4. Welding of the bow doors

On Tuesday October 4th the National Board of Navigation ordered all bow doors in passenger/car ferries making cruises or plying between Helsinki and Stockholm/-Travemünde or between Vaasa and Sundsvall to be closed by welding, so that they cannot be opened. This was to be accomplished by October 6th.

The shipping companies had voluntarily begun to close the bow doors by welding, which caused some initial misunderstandings and confusion. Also the differing and slightly ambiguous orders given by the Finnish and Swedish maritime administrations added to the confusion. Nevertheless, the closing devices of bow doors in Finnish vessels were permanently closed within the time frame.

5. National working groups

On October 5th the Director of the Maritime Safety Department appointed two working groups with the following missions:

Mission of working group on bow doors

1. **To look into** all incidents involving bow doors and find out the reasons for them.

2. **To analyse** the findings of the bow door inspections, carried out by the National Board of Navigation.

3. **To collect** reports from the classification societies on the strength of the bow doors in car and rail ferries built according to their rules.

4. **To sort out** how safety could be enhanced by additional safety and monitoring equipment, alarm devices or by changing the bow door constructions.

5. **To give an account of** the door operation and maintenance manuals on board and make a proposal on how to harmonize them and make them easier to apply, making sure that they are at the disposal of the crew.

6. **To analyse** the findings of the operational controls on board foreign vessels.

7. **To present** a proposal on the harmonization of the safety instructions to passengers.

8. **To present** proposals for national and international measures within the scope of the mission.

Maritime Safety Director Heikki Valkonen appointed the following persons as members of the working group on bow doors:

Director Harri Kulovaara	Silja Line
Director Kaj Jansson	SF-Line
Director Olavi Pylkkänen	Finnlines
Director Hans Fagerström	Det Norske Veritas
Director Gusten Sundman	MacGregor
Director Martin Landtman	Kvaerner Masa-Yards
Naval Architect Joakim Heimdahl	Swedish Maritime Authority
Head of Division Aapo Latvalahti	Finnish National Board of Navigation

Maritime Safety Director Heikki Valkonen from the National Board of Navigation acted as chairman of the working group, and Henri Molander as secretary.

The following experts have contributed to the work of the working group:

Anders Fabritius	Finnish National Board of Navigation
Curt-Olof Eklund	Bureau Veritas
I.F. Segretain	"
Carl Arne Carlson	Det Norske Veritas
K. Magnus Havig	Norwegian Maritime Directorate
Sven Söderlund	Lloyd's Register of Shipping, Helsinki
Alan Gavin	Lloyd's Register of Shipping, London
John A. Burton	"
D.J. Holland	"
Ralf-Erik Lindström	Silja Line

Mission of the working group on life-saving appliances

1. **To determine** the deficiences of existing life-saving appliances when used in helping another ship.

2. **To propose** other improvements with respect to life-saving appliances to be made on board ships, so as to increase their ability to help each other in an emergency.

A separate report has been written on the findings of the working group on life-saving appliances. It is appended to this report.

Summary of the findings of the working group on bow doors

The following sources have supplied information about damages to bow doors:

Lloyd's Register of Shipping
Det Norske Veritas
Bureau Veritas
Kvarner Masa-Yards and
Finnish shipping companies.

On the basis of this information the following conclusions can be drawn:

- The visor construction is more vulnerable to serious damages than the so called butterfly door;

- In cases of damage to butterfly doors, the damage has almost consistently resulted in the doors being wedged, but there has been no risk of them opening;

- In all incidents that have occurred in or in close proximity to Finnish waters, in cases where the exact location is known, the doors have been damaged on the open sea in an area between the peninsula of Hanko and the island of Utö, on westward bound voyages. It is possible that shallow waters in this area create particularly heavy seas when there is a strong southerly or southwesterly wind;

- The bow visors and doors have been designed and dimensioned to the knowledge available at the time of build. According to the latest knowledge the seaload parameters for the bow and doors of older ships have been estimated too low. This is proved by the fact that in remarkably many ships it has been necessary to strengthen the bow and door constructions;

- Estonia, and possibly also other ships fitted with a visor, run a risk that, if their visor breaks off, it may force the ramp open;

- The design pressure values of the classification societies have substantial differences.

These conclusions motivated the following preliminary action plan:

- Verification that the doors of all passenger/car ferries have an additional storm securing for the lockings;

- Verification that the hydraulic door opening and closing system in passenger/car ferries prevents the doors from being opened by mistake;

- Determination of new repair and rejection limits for bow door and visor constructions in order to render surveys more effective;

- Verification of the bow and door strength calculations and constructions in Finnish car ferries, in the light of the latest knowledge. Particular emphasis will be placed on the dimensioning of the seaload;

- Checking of the visor constructions, making sure that the visor cannot break the ramp open;

- The need for specific recommendations on routes leading past the shallow areas, where the wind may cause unusually rough seas will be sorted out by consulting the officers on the passenger vessels. Another alternative to be considered is speed limits in these areas;

- Means to improve ship safety using damage detectors and alarm systems will be sorted out.

Comparison of class rules

The calculations made by Kvaerner Masa-Yards and MacGregor gave the following results:

- The design pressure levels in the bow, as calculated by DNV rules, are in some areas almost three times as high as those calculated on the basis of the formulas of other classification societies.

- DNV operates with at least 30% greater design forces for bow door closing and monitoring than the other classification societies.

- When using the calculation methods of DNV, the dimensioning criterion is normally the design bow impact pressure, which depends on the shape of the bow area. The rules of the other classification societies do not have similar criteria.

It could, however, be concluded that even DNV rules need revision and elucidation with respect to the closing and monitoring systems. These further requirements are presented in the MacGregor memorandum of 12 October 1994. The proposals made in that memorandum are discussed in greater detail in the report from the first meeting (24.10.1994) of the Nordic working group on bow doors.

Bow door operation and maintenance manuals

The proposals of MacGregor and Silja Line will be incorporated into an operation and maintenance manual for bow and stern doors. The manual will include an appendix, where all door maintenance and repair work have to be recorded and confirmed by signature.

Instructions to passengers

Silja Line and SF-Line will jointly prepare safety information for passengers. The point of departure has been the passenger's need for information and the availability of the information from the passenger's point of view. An outline is expected to be completed shortly.

6. Nordic cooperation

On October 17th the Nordic maritime safety directors met in Malmö in order to coordinate the measures of the Nordic countries. The following topics were discussed:

- The stability of car ferries in case water is permeating the car deck and the space under the bulkhead deck is partially damaged (side collision);

- The construction and dimensioning of bow doors and their closing devices, and other safety factors in conjunction with them;

- Evacuation of passengers;

- Life-saving appliances of ships.

Four Nordic working groups were assigned to carry out research:

* Norway will take responsibility for the working group on the stability of a damaged ship;

* Finland will lead the research on bow doors;

* Sweden will take charge of evacuation matters;

* Denmark will lead work on life-saving appliances.

The Swedish and Finnish maritime safety directors agreed to harmonize the requirements for passenger registration in the traffic between the two countries.

The working groups presented a progress report to the following meeting of the Nordic maritime safety directors in Copenhagen on October 31st.

7. The Nordic working group on bow doors

The Nordic working group on bow doors convened for the first time in Helsinki on October 21st.

The working group consists of the following members:

S. Kildevang Jensen	Danish Maritime Authority
Preben Terndrup Petersen	The Technical University of Denmark
Konrad Magnus Havig	Norwegian Maritime Directorate
Joakim Heimdahl	Swedish Maritime Authority
Anders Fabritius	National Board of Navigation, Finland
Heikki Valkonen	National Board of Navigation, Finland

The meeting appointed Mr Heikki Valkonen chairman of the working group.

Referring to the preliminary work done in Finland by Kvaerner Masa-Yards and MacGregor, the meeting concluded that the design pressure levels in the bow, calculated according to DNV rules, are in some areas almost three times as high as those calculated using the formulas of other classification societies. According to DNV, the design forces on bow door closing and securing devices are at least 30 % greater than those of the other classification societies. When using the calculation methods of DNV, the dimensioning criterion is normally the design bow impact pressure, which depends on the shape of the bow area. The rules of the other classification societies do not have similar criteria.

It could, however, be concluded that even DNV rules need revision and elucidation with respect to the closing and monitoring systems. These further requirements are presented in the MacGregor memorandum of October 12th and in the enclosed minutes of the first meeting (24.10.1994) of the Nordic working group on bow doors.

The working party was of the opinion that every ship has to be so designed that its entire construction will resist the worst sea state in the area where the ship is intended to operate, if the ship is heading at full speed against the wind, and that every door has to be built and closed so that it resists the same pressure as the corresponding fixed constructions.

It was further agreed to ask DNV to consolidate the proposals from the MacGregor submission adopted by the working group, to its class rules. Det Norske Veritas has indicated that its Nordic Technical Committee will assemble on November 22nd in Oslo to incorporate these proposals into its class rules.

The meeting was of the opinion that the bow doors of existing passenger vessels calling regularly at Nordic ports, irrespective of when they were built or in which classification society they were classed, should fulfil the same requirements as DNV class rules stipulate after the amendments mentioned above.

New passenger/car ferries operating on the open sea should not be equipped with visor type bow doors.

Additionally, the working group proposed that the Nordic maritime safety directors should require the International Association of Classification Societies (IACS) to harmonize the rules of its member societies to correspond with the DNV rules.

Propositions of the Finnish working group

1) Bow doors will be allowed in new passenger/car ferries on the condition that their construction and closing devices are of equal strength as fixed constructions and that there are specific reasons for using bow doors. The trade area, the nature of the trade and, in particular, the extent to which the ship could face sea pressure, are considered as such specific reasons.

2) Visor type bow doors are not allowed in new ships intended for open sea voyages.

3) Bow and bow door constructions in all vessels shall meet the DNV class rules as amended in the provisions adopted at the meeting of the Nordic maritime safety directors on November 3rd. Therefore every shipping company shall inspect their vessels fitted with bow doors in detail and make sure that these meet the said requirements. The calculations and possible repairs shall be approved by the classification society concerned and the Administration shall be notified of the approval.

4) Every car and rail ferry shall have a door operation and maintenance manual, approved by the Administration. The manual shall include a separate appendix for maintenance and repair. The appendix shall be presented at surveys and inspections.

5) The inspection of bow doors shall be included in the annual surveys carried out by the Administration. Whenever possible, such surveys shall be carried out in cooperation with a representative of the classification society concerned.

6) Existing visor constructions shall be inspected, making sure that the visor, if it breaks off, cannot damage nor open the ramp.

7) The bow doors and ramp shall be equipped with the monitoring and alarm devices presented in the annex to this report.

8) A paragraph stressing the need to take the sea state and the sea area into account shall be included into the passage planning instructions.

9) Harmonized information for passengers on the safety procedures on board shall be compiled.

10) If the results of the Nordic working groups on ship stability, life-saving appliances and evacuation necessitates still other provisions as regards ship construction or equipment, such provisions, along with the above requirements, shall apply to all passenger/ car ferries calling at Finnish ports, irrespective of the flag they are flying.

The measures outlined above shall be taken before the bow doors that are now permanently closed may be opened. The same will be required of other ships by 1 June 1995.

Helsinki, 3 November 1994

Heikki Valkonen
chairman

Harri Kulovaara

Kaj Jansson

Olavi Pylkkänen

Hans Fagerström

Gusten Sundman

Martin Landtman

Joakim Heimdahl

Aapo Latvalahti

A few reservations have been made to the report.

C. Bow Doors and their Closing and Securing. Det Norske Veritas Pt.5 Ch.2 Sec.3

102 Where bow doors are leading to a complete or long forward enclosed superstructure, an inner door is to be fitted. The inner doors is to be part of the collision bulkhead. A vehicle ramp may be arranged for this purpose, provided the regulations concerning the position of the collision bulkhead are fulfilled, see Sec.2 B200. No part of the ramp or its extension may extent forward of the limits specified for the collision bulkhead. If this is not possible a separate inner watertight door with equal strenght as a collision bulkhead has to be installed.

103 Bow doors are to be so fitted as to ensure tightness consistent with operational conditions and to give effective protection to inner doors. Inner doors and the collision bulkhead are to be watertight to the full height of the cargo space, and are to be arranged with supports on the aft side of the doors.

Inner doors are to be dimensioned for the minimum manouvering speed for the greater of:
- Bow impact loading p_{sc} as indicated in C402
- Ordinary design sea pressure p_e as indicated in C401

Bow doors and inner doors to be arranged so that geometric interaction in case of bow door damage is avoided.

302 Steel forgings or castings used in the securing, supporting and manoeuvring components are to be of approved ductile materials, duly tested in accordance with the requirements of Pt.2. The material factor f_1 for forgings (including rolled round bars) and castings may be taken as:

$f_1 = (\sigma F/235)^{0,75}$

σF = minimun upper yield stress in N/mm^2, not to be taken greater than 70 % for the ultimate tensile strength.

For closing devices the material factor may not be taken greater than 1.0 unless a direct fatigue analyses is applied.

402 The design bow impact pressure:

P_{sc} = as given in Pt.3 Ch.1 Sec.7 E300.

404 The design forces (in kN) on each half of the bow door for securing bolts and other closing devices, supporting members and surrounding structure are given by (See Fig. 1):

External forces:

- Total longitudinal force:
  $F_x = (0,375p_{sc}A_x)$ or $(1,3\ p_eA_x)$ if greater.

- Total transverse force:
  $F_y = (0,375p_{sc}A_y)$ or $(1,3p_eA_y)$ if greater.

- Total vertical force:
  $F_z = (0,375p_{sc}A_z)$ or $(1,3p_eA_z)$ if greater.

A_x = area in m^2 of the vertical front view projection of the bow door, on one side of the centre line.

A_y = area in m^2 of the vertical side view projection of the bow door.

A_z = area in m^2 of the horizontal projection of the bow door, on one side of the centre line.

Pressures are to be calculated at h/2 as follows:

- In x-direction at a point situated 0,125 b from centre line.
- In y-direction at 1/2.
- In z-direction at 1/2.

Internal forces:

- Total longitudinal force: $F_{xi} = p_i A_x$
- Total transverses force: $Fyi = p_i A_y$

Image
Fig. 1
Bow Doors.

802 Closing devices are to be simple to operate and easily accessible. Closing devices to be of mechanically selflocking or gravity type and equipped with additional securing appliences. The opening and closing systems as well as locking and securing devices should be interlocked in such a way that they can not be operated in the wrong sequence.

803 Bow doors are to be provided with closing devices with an arrangement for remote control from a convenient position and with indication of the open/closed position of every bow door as well as every closing and securing device. The operating panel for remote controlled bow doors is to be inaccessible to unauthorized persons.

805 Where hydraulic cleating is applied, the system is to be mechanically lockable in closed position. This is to be understood to mean that, in the event of failure of the hydraulic system, the cleating will remain locked. Closing and securing cleatings to be isolated from the main hydraulic system and from other hydraulic circuits, when in closed position. The drive mechanisms of the locking devices to be constructed so that the power needed for unlocking is bigger than the power needed for locking.

806 Indicators and audible alarms are to be provided on the operating panel and on the navigation bridge for each shell door, loading door and other closing appliance and their locking devices and securing appliences which, if left open or not properly secured, could lead to major flooding of a special category space or Ro-Ro cargo space.

The indicator system is to be designed on the fail to safe principle and is to show if the door, its locking devices or their securing appliances are closed or open.

The indicators on the operation panel to show if the door, its locking devices and their securing appliances are open or closed. The indicators on the navigation bridge to show the position of each door (common indication for the door, its locking devices and their securing appliances open or closed).

The indication panel to be provided with a lamp test function.

The indication panel on the navigation bridge to be equipped with a mode selection function "harbour/sea voyage", connected to an approved location in the propulsion system e.g. the tachometer of the propeller shaft, and activating an audible alarm if one limit switch opens when the sea voyage mode is on.

The sensors of the indicator system to be protected from water, ice formation and mechanical damages.

The power supply for the indicator system is to be independent of the power supply for operating and securing the doors.

807 Means are to be arranged to provide an indication with audible alarm to the navigation bridge of any leakage through bow doors or any other cargo or vehicle loading doors which could lead to major flooding of special category spaces or Ro-Ro cargo spaces.

All such doors, including the bow doors and visor, to be provided with a television surveillance system with a monitor on the navigation bridge and in the engine control room. The system must monitor the position of the door and its locking devices. Special consideration to be given for sufficient lighting and contrasting colour of objects under surveillance.

810 A drainage system by pumping should be arranged in the area between bow door and ramp, as well as ramp and inner door. The system is to be equipped with an audible alarm function for water level exceeding 1 m above the car deck level.

901 The maximum forces acting on the securing and supperting devices are to be estimated on the basis of the external or internal forces given in C404. The following cases are to be considered:

The bow door construction must withstand a failure in any of the closing devices and still fullfill all requirements under this item.

1) Sum of supporting forces in each direction (longitudinal, transverse, horizontal) are to balance with the design forces.

In the vertical direction the design force is given by (in kN):

F_z or (2,5 blh)

Whichever is the greater.
b,l and h are the breadth, length, height of the bow door (in m) as given on Fig.1.

2) In each plane (longitudinal, transverse of horizontal) the sum of moments of the support forces is to balance the sum of moments of the design forces in the particular plane.

Only effective supporting/securing devices are to be included. A small number of strong devices to be fitted, rather than a large number of less strong devices. Available space for adequate support in the hull structure may, however, limit the size of each device. For doors with a complex supporting/securing arrangements, direct calculation of the support forces of securing devices may be required.

Unless the support system for the doors is statically determined the calculation method must take into consideration the flexibility of structures and the location of design forces and supports.

904 Allowable stresses in the supporting and securing devices are as follows:

Table C2 Allowable stresses.

*)

Design pressure $p(N/mm^2)$	Shear stress τ (N/mm^2)	Bending or normal stress σ (N/mm^2)	Equivalent stress σ (N/mm^2)	Bearing stress in supports σ (N/mm^2)
$1.3p_e 1.3p_i$	80	120	150	30
$0.375p_{se}$	80	120	150	120

*) determined as load devided by projected bearing area.

Anyway the maximum tension in way of threads of bolts is allowed to reach 125 f_1 N/mm^2 for bolts not bearing support forces.

1001 Where packing is required the packing material is to be of a comparatively soft type, and the supporting forces are to be carried by the steel structure only. Other types of packing will be specially considered.

The forward part of the hull should have equal strength as required to the bow doors above.

Every car and rail ferry has to have an operation and maintenance manual for ports, which is accepted by the Administration. The manual has to include a separate register for maintenance and repair. The register has to be presented in surveys and inspections.

For ferries operating in protected area or restricted sea condition, the Administration may accept requirements other than those specified in this document, provided that the total safety of the vessel is maintained at the same level.